Tillage and Crop Residue Management

Identifying and recording the tillage, planting, and harvest operations within a crop rotation is an important step in determining the soil loss that may occur on a cropland field. Tillage is a sequence of mechanical operations that lifts and pulverizes soil structure to kill weeds and incorporate surface residue, level the soil surface, incorporate pesticides and fertilizers, and make the soil surface firm but friable for the planting of the next crop. Tillage may be periodically repeated to fill and cover over rill and ephemeral gully erosion while removing compaction and crusting from rain events and of course, terminating weed growth.

The Revised Universal Soil Loss Equation, Version 2 (RUSLE2) model is used to estimate the potential soil erosion by water based on the location, topography, soil type, farming operations and crop rotation, and structural practices installed to control runoff. The model also provides the planner with an assessment of the Soil Conditioning Index (SCI) and the Soil Tillage Intensity Rating (STIR). The SCI value is calculated based on field operations and the effect on soil erosion and soil organic matter; a positive value shows an increase in improving the soil organic matter condition of the soil. The STIR value is based on the annual soil disturbance (tillage, planting, and harvesting).

CONVENTIONAL TILLAGE

Tillage that occurs with the main focus of residue management, pest suppression, land forming, or soil conditioning is an intense disruption in the surface layers of soil. Soil is displaced and thrown from tillage equipment in contact with the soil. Soil structure is destroyed, and soil particles are pulverized. This type of soil tillage makes the soil susceptible to soil erosion and offsite sediment movement by destroying the natural processes to consolidate soil particles. Tillage operations are generally full width implements; the entire field has the soil surface disturbed and displaced.

Tillage implements used as the primary conventional tillage operation are moldboard plows, chisel plows, chisels, sweeps, heavy disks, powered rototillers, and bedders. Secondary operations are smaller and lighter disks, harrows, packers, ground-driven rotary tillers, field cultivators, field conditioners, rollers, bed shapers, and rotary hoes. Light tillage may occur immediately prior to planting merely to kill weeds that have emerged. Tillage to cultivate the crop after planting to remove undesired vegetation may be row crop implements with ground-driven rotary tines, spring tooth tines, shank tine cultivators, rotary hoes, or power-driven rotary tillers. Using tillage for weed control after a crop has been planted is risky – the equipment operator must have the tillage tool set to remove weeds without damaging the planted crop.

Combination tools that perform primary and secondary tillage in one pass may be used. These combination tools may include coulter blades to cut and size surface residue, subsoiler shanks to lift and fracture the soil, or chisel plow shanks and disk blades to fluff and displace soil while covering residue. Secondary tillage tools may be incorporated in a combined tool to “dress up” the field by leveling ridges, filling furrows, packing the surface, or crumbling soil aggregates. RUSLE2 calculations must account for each of these separate operations that occur in a one-pass

tillage system. In some cases, even the planting equipment is attached to the tillage tool to reduce time and fuel to get the crop planted.

Conventional tillage will generally have an SCI value that is negative (-) value showing that the farming system is not building soil organic matter and a STIR that is higher than 60. Residue is usually less than 15 percent ground cover with conventional tillage. In most cases this amount of crop residue is not a significant factor in reducing soil erosion by wind or water.

REDUCED TILLAGE (conservation tillage including Vertical Tillage)
Reduced tillage is used when there is a need to maintain surface residue from harvest to planting time for soil surface protection from wind or water erosion forces. The surface residue is maintained at 30 percent ground cover or higher to provide some mulching effect – allowing crop seedlings to germinate and emerge with some protection from the forces of nature.

The goal with reduced tillage is to leave residue on the surface equal to or in excess of 30 percent ground cover while controlling the weed population and preparing a firm seedbed for the planting of the next crop. Tillage operations are the full width of the implement and will disturb the entire soil surface for the field.

The RUSLE2 SCI with reduced tillage may be either a negative or positive value depending on the type of tillage used. The STIR value is generally between 20 and 60 showing significant soil disturbance.

Vertical Tillage
Vertical tillage is a type of full-width tillage equipment and is an attempt to reduce the impact of conservation tillage on the soil surface by using implements that merely till narrow bands, zones, or strips of soil with shanks or smooth coulters entering and exiting the soil on a vertical plane. The primary reason to use vertical tillage is to size heavy residue for planting operations with minimal lateral displacement of soil. The secondary reason is to remove compaction with shanks or coulters pulled through compacted zones. These tillage operations occurring together in one implement are not part of a “no till” system – too much soil is moved and displaced to be considered no till. But the operation may be considered reduced tillage based on the amount of surface soil disturbance, horizontal soil displacement, and residue destruction. True vertical tillage implements size residue but are not residue management implements.

Very few of the implements sold as “vertical tillage” actually work as described above. The implements are generally set at a shallow draft and are pulled at speeds often as high as 8 to 10 miles per hour. A review of a sampling of these vertical tillage implements sold by common manufacturers have shown that the majority of the implements are merely another form of the basic disk harrow. Check equipment out either in the farmer’s equipment lot or on-line to determine the tillage accomplished. Since there are many different combinations of tillage tools that can be used on this equipment, a planner must be able to identify the RUSLE2 operations that are being performed.

Below is a representation of some of the tools sold as vertical tillage. **The information below is not an endorsement for any equipment but rather developed as an education guide to help with the proper selection of the RUSLE2 operation.** All of these implements may be configured with different or additional attachments than described here.

- **Alamo Earthmaster Verti-Go MWT3400**: two gangs of 25-tooth concave disk blades on 7.5-inch spacing sold at a gang angle setting of 18 degrees designed to move soil horizontally. Implement also includes a seedbed finisher. This implement does **NOT** meet the definition of a vertical tillage tool; it is a tandem disk harrow with seedbed finisher.
  Example RUSLE2 operation:
  Coulter tiller, 10 degree angle, coiled tine harrow, rolling basket – STIR 21

- **Blu-Jet Coulterpro**: two rows of individually mounted coulters used to size residue prior to planting. This tool is a vertical tillage implement and a strip till operation only when the disturbed soil area is less than 30 percent of the narrowest row width in the crop rotation. With no till the crop must be planted in all the tilled strips.
  Example RUSLE2 operations:
  1) **Coulter caddy, with fluted coulters – STIR 8.6 or**
  2) **Coulter caddy, with smooth coulters – STIR 3.4**

- **Case IH True-Tandem 330 Turbo**: two offset gangs of disk blades at 18 degree angle designed to move soil horizontally. This implement does **NOT** meet the definition of a vertical tillage tool; it is a tandem disk harrow. This is not a "no till" operation.
  Example RUSLE2 operation:
  Coulter tiller, 10 degree angle, coiled tine harrow, rolling basket – STIR 21

- **Case IH Ecolo-Til 2500**: individual coulter for each ripper shank. Minimal surface disturbance with sizing residue and lifting and fracturing soil. This implement is a vertical tillage tool by definition but does not qualify as a no till operation due to the amount of soil displaced.
  Example RUSLE2 operation:
  Subsoiler, inline with coulter caddy – STIR 35

- **Degelman Pro-Till**: A compact disk cultivator with independently mounted disks on 10-inch spacing set at 16 degrees. This implement does **NOT** meet the definition of a vertical tillage tool; it is a tandem disk harrow with a strip roller packer. This is not a "no till" operation.
  Example RUSLE2 operation:
  Coulter tiller, 10 degree angle, coiled tine harrow, rolling basket – STIR 21

- **Gates Magnum Coulter Disk**: implement is gangs of coulters mounted for on-the-go hydraulic adjustment from 0 to 15 degree angle. Gangs may have an optional manual adjustment at 0, 5, 10, or 15 degrees. This is a vertical tillage implement only when pulled through the field with gangs set at a 0 degree angle to the direction of travel. Any other setting that angles the coulters in relation to the direction of travel would make this tool a disk harrow and would **NOT** meet the definition of a vertical tillage implement. This is not a "no till" operation.

Example RUSLE2 operations:

0-degree angle – Seedbed conditioner, coulter caddy, coil tine harrow, rolling basket – STIR 21

5 to 15 degree angle – Coulter tiller, 10 degree angle, coiled tine harrow, rolling basket (combination tool) – STIR 21

- **Great Plains Ag**

  Turbo-Chopper: a combination tillage tool with 20-inch diameter turbo coulters spaced every 10 inches, 18-inch diameter chopper reels with 6 blades, a series of rolling spike harrows, and a rolling reel harrow. The turbo coulters, chopper reels, and rolling spike harrows effectively disturb and till the entire soil surface. This tool does **NOT** meet the definition of a vertical tillage implement. This is not a "no till" operation.

  Example RUSLE2 operation:

  Seedbed finisher, single disk, field cultivator coil tine harrow, rolling basket – STIR 37

  Turbo-Max: a combination tillage tool with 2 offset gangs of turbo coulters spaced at 7½ inches (effective tillage every 3¾ inches). Angle on the gangs can be set from the tractor seat at 0^0 to 6^0 making this implement into a tandem disk. Common attachments are a rotary spike-toothed harrow and rolling basket. This tool does **NOT** meet the definition of a vertical tillage implement. This is not a "no till" operation.

  Example RUSLE2 operation:

  Coulter tiller, 10 degree angle, coiled tine harrow, rolling basket – STIR 21

  Turbo-Till: a combination tillage tool with 2 offset gangs of turbo coulters, angled rotary spike-toothed harrows, and a rolling reel. The entire soil surface is disturbed with this equipment with some lateral movement of soil. Implement is used to size residue and cover residue with soil to speed decomposition. This is not a "no till" operation.

  Example RUSLE2 operation:

  Coulter tiller, 10 degree angle, coiled tine harrow, rolling basket – STIR 21

- **HCC Smart-Till**: an aeration tillage tool with multi-tine disks mounted on angled gangs to be operated at shallow depths up to a maximum of 8 inches deep. This implement disturbs the entire soil surface and does **NOT** meet the definition of a vertical tillage tool. This is not a "no till" operation.

  Example RUSLE2 operations:

  Harrow, rotary – STIR 10

- **Kongskilde Vertical Tillage 9100**: coulters in gangs that can be angled to the direction of travel at 0, 4, 8, 12, or 16 degrees. Coulters are mounted at an 8-inch spacing. This implement is a vertical tillage tool only when set at an angle of 0 degrees; when set at the 4, 8, 12, or 16 degree settings, this tool does **NOT** meet the definition of a vertical tillage tool and tills the soil as a tandem disk. This is not a "no till" operation.

  Example RUSLE2 operations:

  0-degree angle – Coulter tiller and spike harrow – STIR 19

4-16 degree angle – Coulter tiller, 10 degree angle, coiled tine harrow, rolling basket – STIR 21

- **Kuhn Krause Excelerator 8000**: fluted coulter blades with scalloped edges mounted on gangs adjustable from 1 to 5 degrees. There are gangs of "star wheels" following the coulter blades set at a 6 degree angle and designed to fluff the surface soil while killing small weeds. The implement is designed to throw soil somewhat like a disk and a rotary hoe combination. This tool does **NOT** meet the definition of a vertical tillage tool. This is not a "no till" operation.
  Example RUSLE2 operation:
  Coulter tiller, 10 degree angle, coiled tine harrow, rolling basket – STIR 21

- **Landoll Series 7400 VT Plus**: shallow concave disk blades mounted in gangs spaced every 7 inches set at a 10-degree angle. This implement is a tandem disk and does **NOT** meet the definition of a vertical tillage tool. This is not a "no till" operation.
  Example RUSLE2 operation:
  Disk, tandem secondary operation – STIR 33

- **Mandako Twister**: angled coulters up to 9 degrees with spring-tooth harrow or Phillips harrow attachment. Very aggressive tillage with significant horizontal soil movement – this implement does **NOT** meet the definition of a vertical tillage implement. This is not a "no till" operation.
  Example RUSLE2 operation:
  Coulter tiller and spike harrow – STIR 19

- **McFarlane Reel Disk**: an angled gang of disks followed by a chopper reel, a spiked tooth harrow, and a rolling reel basket. This implement does **NOT** meet the definition of a vertical tillage tool. This is not a "no till" operation.
  Example RUSLE2 operation:
  Coulter tiller, 10 degree angle, coiled tine harrow, rolling basket – STIR 21

- **Salford Residue Tillage Specialist Extreme (RTS XT)**: two rows of individually mounted coil spring coulters. This is a vertical tillage implement and can be a strip till operation if the crop is planted in the tilled strips.
  Example RUSLE2 operation:
  Coulter caddy, double gang with fluted coulters – STIR 16

- **Summers Supercoulter Plus**: two gangs of coulters mounted at a 0-degree angle. This is a vertical tillage implement and can be a strip till operation if the crop is planted in the tilled strips
  Example RUSLE2 operation:
  Coulter caddy, double gang with fluted coulters – STIR 16

- **Sunflower 6630 Series**: two offset gangs of scalloped disk blades at an 18-degree angle to the frame. This implement does **NOT** meet the definition of a vertical tillage tool. This is a tandem disk with gangs set at the standard 18 degree angle. This is not a "no till" operation.

Example RUSLE2 operation:
Disk, tandem secondary operation – STIR 33

NO TILL
No full width tillage operation in contact with the soil is allowed under this tillage classification. From harvest of the previous cash crop to harvest of the current cash crop, the soil is kept covered in crop residue and the soil has very minimal disturbance from mechanical operations. The planter or drill may be equipped with a coulter to cut residue, residue fingers or wheels to move residue, stronger springs to increase down pressure, extra weight on the planting unit for better penetration, and disk seed-furrow or hoe openers. The area between rows may have as much as 30 percent of the surface soil disturbed (strip till) during or just prior to the planting operation and still qualify as a no till operation. Global positioning technology may allow two operations (sizing residue and planting) to occur at separate times but within the same zone not significantly disturbing the soil area between rows.

The RUSLE2 SCI for no till will usually be a positive value as soil erosion should not be a major concern and there are no field operations that are destroying soil organic matter. The STIR value will be less than or equal to 20 with the most desired farming systems having a STIR value less than 10.

SUMMARY
The following table lists all RUSLE2 operations and STIR values as of April 2019 that may be selected when modeling the farming system. The wording used here is a little different from how it is displayed in the RUSLE2 model as the majority of the abbreviated words have been fully written out to assist the RUSLE2 user with understanding the operation.

Complete RUSLE2 Operations Database

Add PAM (polyacrylamide) – STIR 0.15
Add mulch
Aerator, field surface, ground driven – STIR 12
Aerator, field surface, ground driven 0 degree offset – STIR 7.0
Aerator, field surface, ground driven 10 degree offset – STIR 23
Aerator, field surface, ground driven 5 degree offset – STIR 12
Aerator, single drum, lugs, angle 0 – STIR 12
Aerator, tandem drum, lugs, angle 10 – STIR 35
Aerator, tandem drum, lugs, angle 5 – STIR 28
Aerial interseeding
Aerial overseeding
BFM (bonded fiber matrix) application – STIR 0.15
Bale Corn husk, cob and chaff windrows – STIR 0.15
Bale Corn stalk strips – STIR 0.15
Bale combine windrows – STIR 0.15
Bale corn stover – STIR 0.15
Bale straw or residue – STIR 0.15
Bed shaper – STIR 20
Bed shaper high disturbance – STIR 26
Bed shaper, 12-inch – STIR 20
Bed shaper, 12-inch, low flattening – STIR 20
Bed shaper, low flattening, high disturbance – STIR 26
Bedder, hipper, disk hiller – STIR 26
Bedder, hipper, disk hiller after small grains – STIR 26
Bedder, hipper, hiller 12 inch high – STIR 39
Bedder, hipper, hiller 15 inch high – STIR 46
Bedder, hipper, hiller 18 inch high – STIR 52
Begin growth
Begin new growth
Begin weed growth

Bulldozer, clearing/cutting – STIR 16

Bulldozer, clearing/cutting light – STIR 0.83

Bulldozer, filling/leveling – STIR 5.2

Burn residue

Burn residue, high intensity

Burn residue, low intensity

Burn residue, moderate high intensity

Burn residue, moderate intensity

Chisel plow, coulter, straight points – STIR 53

Chisel plow, coulter, straight points, cover disks – STIR 56

Chisel plow, coulter, straight points, cover disks, rolling basket – STIR 70

Chisel plow, coulter, sweeps – STIR 53

Chisel plow, coulter, twisted points – STIR 53

Chisel plow, coulter, twisted points, cover disks – STIR 56

Chisel plow, disk, straight points – STIR 65

Chisel plow, disk, straight points, cover disks – STIR 69

Chisel plow, disk, twisted points – STIR 65

Chisel plow, disk, twisted points, cover disks – STIR 69

Chisel, 12 to 16-inch low crown sweep 3 to 4-inch depth – STIR 25

Chisel, straight point – STIR 46

Chisel, straight point 12-inch deep – STIR 62

Chisel, straight point 15-inch deep – STIR 78

Chisel, straight point 5-inch deep – STIR 33

Chisel, straight point 5-inch deep, coil tine harrow – STIR 35

Chisel, straight point, coil tine harrow – STIR 48

Chisel, sweep shovel – STIR 46

Chisel, sweep shovel 5-inch depth – STIR 33

Chisel, sweep shovel 5-inch depth, coil tine harrow – STIR 35

Chisel, sweep shovel, coil tine harrow – STIR 48

Chisel, twisted shovel – STIR 46

Chisel, twisted shovel (duplicate record - do not use)

Chisel, twisted shovel, coil tine harrow – STIR 48

Chisel, winged with furrow diker – STIR 74

Continuous disturbance and smoothing – STIR 19

Coulter caddy, double gang with fluted coulters – STIR 16

Coulter caddy, with fluted coulters – STIR 8.6

Coulter caddy, with smooth coulters – STIR 3.4

Coulter tiller and spike harrow – STIR 19

Coulter tiller, 10-degree angle, coiled tine harrow, rolling basket – STIR 21

Cover crop underseeder – STIR 1.6

Cultipacker, roller – STIR 36

Cultivate, manually – STIR 3.9

Cultivate, manually, low intensity – STIR 2

Cultivate, manually, moderate intensity – STIR 2.9

Cultivate, rows manually – STIR 3.9

Cultivator, between beds, add residue – STIR 9.8

Cultivator, field 6 to 12-inch shovels Central – STIR 31

Cultivator, field 6 to 12-inch sweeps – STIR 26

Cultivator, field w/ spike points – STIR 31

Cultivator, field w/ spike points, coil tine harrow – STIR 34

Cultivator, flame – STIR 0.15

Cultivator, hipper, disk hiller on beds – STIR 6.5

Cultivator, off bar w/disk hillers on beds – STIR 6.5

Cultivator, rotary – STIR 6.6

Cultivator, rotary on beds – STIR 6.6

Cultivator, rotary on beds; **Bedder**, hipper, disk hiller – STIR 27

Cultivator, row - 1st pass ridge till – STIR 18

Cultivator, row - 2nd pass ridge till – STIR 20

Cultivator, row 1-inch ridge – STIR 15

Cultivator, row 3-inch ridge – STIR 18

Cultivator, row between beds – STIR 11

Cultivator, row, high residue – STIR 8.1

Detasseler, seed corn – STIR 0.15

Disk, inter row strips – STIR 17

Disk, offset, heavy – STIR 39

Disk, offset, heavy 12-inch depth – STIR 78

Disk, offset, heavy 15-inch depth – STIR 78

Disk, offset, heavy, roller, corrugated packer – STIR 41

Disk, offset, heavy, roller, smooth – STIR 40

Disk, oxen, strip 30 percent disturb – STIR 3.1

Disk, oxen, strip 60 percent disturb – STIR 6.2

Disk, single gang – STIR 20

Disk, tandem heavy primary operation – STIR 39

Disk, tandem heavy primary operation, roller, smooth – STIR 40
Disk, tandem light finishing – STIR 20
Disk, Tandem secondary and rolling basket – STIR 41
Disk, tandem secondary operation – STIR 33
Disk, tandem, shallow, no kill crop – STIR 20
Do all (Duall) – STIR 54
Do all, on beds – STIR 26
Dozer track walking – STIR 0.98
Drill or air seeder single disk openers 7-10 inch spacing – STIR 2.4
Drill or air seeder single disk openers, fertilizer openers 7-10 inch spacing – STIR 5.7
Drill or air seeder tee slot openers 7-10 inch spacing – STIR 2.0
Drill or air seeder, combo field cult, double disk openers – STIR 29
Drill or air seeder, combo single disk-hoe openers, 10-inch spacing – STIR 16
Drill or air seeder, hoe opener inch heavy residue – STIR 17
Drill or air seeder, hoe opener inch heavy residue w/ fertilizer openers – STIR 20
Drill or air seeder, hoe/chisel openers 12 to 15-inch spacing – STIR 21
Drill or air seeder, hoe/chisel openers 12 to 15-inch spacing w/ fertilizer openers – STIR 24
Drill or air seeder, hoe/chisel openers 6 to 12-inch spacing – STIR 23
Drill or air seeder, hoe/chisel openers 6 to 12-inch spacing w/fertilizer openers – STIR 27
Drill or air seeder, paired, opposing single disk openers 6x9 inch spacing – STIR 17
Drill or air seeder, double disk opener w/ fluted coulter 5x10 paired row – STIR 12
Drill or air seeder, double disk – STIR 6.3
Drill or air seeder, double disk opener, w/ fertilizer openers – STIR 14
Drill or air seeder, double disk, w/ fluted coulters – STIR 7.2
Drill or air seeder, offset double disk openers – STIR 4.1
Drill or air seeder, 4-inch stealth openers on 12-inch spacing – STIR 9.8
Drill or air seeder, 6-inch stealth openers on 12-inch spacing – STIR 10
Drill or air seeder, sweep or band opener – STIR 9.8
Drill, deep furrow 12 to 18-inch spacing – STIR 23
Drill, deep furrow 7 to 10-inch spacing – STIR 25
Drill, double disk, 7 to 8-inch packer Central – STIR 11
Drill, double disk, orchard vineyard cover – STIR 39
Drill, heavy, direct seed, double disk opener – STIR 17
Drill, heavy, direct seed, double disk opener w/row cleaners – STIR 18
Drill, semi-deep furrow 12 to 18 inch spacing – STIR 22
Drip tape extractor – STIR 2.6
Drip tape injection shank – STIR 2.6
Drip tape injection shank on beds – STIR 2.6
Drip tape injector bed shaper – STIR 26
Erosion blanket application – STIR 0.15
Fertilizer applicator anhydrous knife 12 inches – STIR 6.5
Fertilizer applicator anhydrous knife 12 inches, coil tine harrow – STIR 20
Fertilizer applicator broadcast by hand – STIR 0
Fertilizer applicator coulter, high pressure inject 12-inches -STIR 2.0
Fertilizer applicator deep placement heavy shank – STIR 13
Fertilizer applicator shank low disturbance, 12 inches – STIR 3.3
Fertilizer applicator shank low disturbance, 12 inches, coil tine harrow – STIR 16
Fertilizer applicator shank low disturbance, 15-inch spacing – STIR 2.6
Fertilizer applicator side-dress, liquid – STIR 0.15
Fertilizer applicator surface broadcast – STIR 0.15
Fertilizer applicator, aerial – STIR 0
Fertilizer applicator anhydrous knife 15-inch spacing – STIR 5.2
Fertilizer applicator anhydrous knife 15-inch spacing high disturbance – STIR 35
Fertilizer applicator anhydrous knife 15-inch spacing high disturbance, coil tine harrow – STIR 48
Fertilizer applicator anhydrous knife 15 inch spacing, coil tine harrow – STIR 18
Fertilizer applicator anhydrous knife 30 inch spacing – STIR 2.6
Fertilizer applicator anhydrous knife 30 inch spacing, bedded – STIR 2.6

Fertilizer applicator anhydrous, minimal disturbance precision placement, 30-inch spacing – STIR 0.51
Fertilizer applicator anhydrous, low disturbance single disk opener, 30-inch spacing – STIR 2.0
Fertilizer applicator double shot knife 15-inch spacing high disturbance – STIR 35
Fertilizer applicator shallow anhydrous knife 38 inch spacing – STIR 2.0
Fertilizer applicator single disk opener, low disturbance, 30-inch spacing – STIR 2.0
Fertilizer applicator, strip-till 30-inch spacing – STIR 5.4
Furrow diker – STIR 7.3
Furrow shaper, torpedo – STIR 2.2
Germination of dormant seeding – STIR 0
Graze, continuous – STIR 0.49
Graze, continuous overgrazing – STIR 0.49
Graze, continuous, heavy hoof traffic – STIR 2.3
Graze, continuous, light hoof traffic – STIR 1.1
Graze, continuous, moderate hoof traffic – STIR 1.8
Graze, intensive rotational – STIR 0.49
Graze, rotational – STIR 0.49
Graze, stubble or residue – STIR 0.49
Graze, stubble or residue 25 percent – STIR 0.49
Graze, stubble or residue 50 percent – STIR 0.49
Graze, stubble or residue 75 percent – STIR 0.49
Grazing set season, time on, time off, rate – STIR 0
Grazing, continuous, high traffic, set season, rate – STIR 0
Grazing, continuous, set season, rate – STIR 0
Grazing, continuous, severe hoof traffic, set season, rate – STIR 0
Grazing, continuous, time on, time off, rate – STIR 0
Grazing, frost kill – STIR 0
Grazing, set end height, and rate – STIR 0
Grazing, set end height, and time on – STIR 0
Grazing, set harvest portion and time on – STIR 0
Grazing, set harvest portion, and removal rate – STIR 0
Grazing, set season, harvest portion, removal rate and start mass – STIR 0
Grazing, set season, start height, end height, rate – STIR 0
Grazing, set season, start height, end height, rate, then mowed – STIR 0.15
Grazing, set season, start height, end height, time on – STIR 0
Grazing, set season, start height, end height, time on, then mowed – STIR 0.15
Grazing, set season, harvest portion, start mass, and time on – STIR 0
Harrow, coiled tine – STIR 16
Harrow, coiled tine weeder – STIR 7.8
Harrow, disk chain – STIR 20
Harrow, heavy – STIR 16
Harrow, heavy on heavy residue – STIR 0.15
Harrow, rolling – STIR 17
Harrow, rotary – STIR 10
Harrow, rotary paddle wheel and spike gangs – STIR 21
Harrow, rotary, light, fluff fragile residue – STIR 4.4
Harrow, rotary, light, fluff residue – STIR 0.73
Harrow, spike tooth – STIR 16
Harrow, spike tooth, cover seed – STIR 16
Harrow, tine, on beds – STIR 7.8
Harvest, broccoli and cauliflower – STIR 0.15
Harvest, cabbage and head lettuce – STIR 0.15
Harvest, cabbage and head lettuce, hand – STIR 0.15
Harvest, combine windrows – STIR 0.15
Harvest, corn cobbage or earlage – STIR 0.15
Harvest, corn grain and 60 percent of residue mass – STIR 0.15
Harvest, corn grain and cobs – STIR 0.15
Harvest, corn grain and part of stover, 14-inch stubble – STIR 0.15
Harvest, corn silage with cover crop – STIR 0.15
Harvest, cotton – STIR 0.15
Harvest, cotton and shred – STIR 0.15
Harvest, cut flowers – STIR 0.15
Harvest, dig root crops 12-inch depth residue buried – STIR 48
Harvest, dig root crops 12-inch depth residue on surface – STIR 47
Harvest, dig root crops residue buried – STIR 27
Harvest, dig root crops residue buried 10-inch ridge – STIR 28
Harvest, dig root crops residue on surface – STIR 14

Harvest, forage sorghum – STIR 0.15

Harvest, fruit crops – STIR 0.15

Harvest, grain, grow cover – STIR 0.15

Harvest, grass or legume seed, burn forage – STIR 0.15

Harvest, grass or legume seed, leave forage – STIR 0.15

Harvest, grass or legume seed, remove forage – STIR 0.15

Harvest, grass seed, remove forage – STIR 0.15

Harvest, hand pick – STIR 0.15

Harvest, hand pick multiple times – STIR 0.15

Harvest, hand pick vegetables – STIR 0.15

Harvest, hand pull – STIR 2.3

Harvest, hay set date – STIR 0.15

Harvest, hay set season, start and end height – STIR 0.15

Harvest, hay, grass – STIR 0.15

Harvest, hay, legume – STIR 0.15

Harvest, hay, no regrowth – STIR 0.15

Harvest, hops – STIR 0.15

Harvest, kenaf – STIR 0.15

Harvest, killing crop 10 percent standing stubble – STIR 0.15

Harvest, killing crop 20 percent standing stubble – STIR 0.15

Harvest, killing crop 20 percent standing stubble, release cover crop – STIR 0.15

Harvest, killing crop 30 percent standing stubble – STIR 0.15

Harvest, killing crop 50 percent standing stubble – STIR 0.15

Harvest, killing crop 50 percent standing stubble, release cover crop – STIR 0.15

Harvest, killing crop 60 percent standing stubble – STIR 0.15

Harvest, killing crop 70 percent standing stubble – STIR 0.15

Harvest, knife, windrow, combine – STIR 6.6

Harvest, leafy vegetables – STIR 0.15

Harvest, leafy vegetables mechanical – STIR 0.15

Harvest, legume seed, remove forage – STIR 0.15

Harvest, onions – STIR 13

Harvest, orchard and nut crops – STIR 0.15

Harvest, residue, forage chopper, complete – STIR 0.15

Harvest, residue, forage chopper, incomplete – STIR 0.15

Harvest, residue, forage chopper, intermediate – STIR 0.15

Harvest, rootcrops, manually – STIR 4.2

Harvest, rootcrops, manually, 25 percent of field disturbed – STIR 2.6

Harvest, rootcrops, manually, 33 percent of field disturbed – STIR 3.4

Harvest, rootcrops, manually, 50 percent of field disturbed – STIR 5.2

Harvest, rootcrops, manually, one third – STIR 3.1

Harvest, seed heads by hand – STIR 0.15

Harvest, silage – STIR 0.15

Harvest, silage 3-foot stubble – STIR 0.15

Harvest, small grain haylage 5-inch height – STIR 0.15

Harvest, small grain silage with cover crop -STIR 0.15

Harvest, small grain, release understory – STIR 0.15

Harvest, snapper header – STIR 0.15

Harvest, sprig rototiller digger – STIR 14

Harvest, stalk chopping corn header – STIR 0.15

Harvest, stripper header – STIR 0.15

Harvest, timber remove tops – STIR 0.15

Harvest, tobacco, burley – STIR 0.15

Harvest, tobacco, burley, mechanical harvester – STIR 0.15

Harvest, tobacco, flue cured – STIR 0.15

Harvest, tobacco, flue cured, 1 pass mechanical – STIR 0.15

Harvest, tobacco, flue cured, selective mechanical harvest – STIR 0.15

Harvest, tree buck – STIR 0.15

Harvest, tree length logs – STIR 0.15

Harvest, tree pulpwood cut – STIR 0.15

Harvest, tree, Christmas grow cover – STIR 0.15

Harvest, trees, chipper – STIR 0.15

Harvest, vine crops – STIR 0.15

Harvest, vine crops, mechanical – STIR 0.15

Harvest, windrows – STIR 0.15

Harvest, woody biomass – STIR 0.15

Hilling, manual hoe – STIR 3.3

Hydro-seeder – STIR 0.15

Install Compost Sock – STIR 0.15

Install Silt Fence – STIR 0.15

Install Straw Bale – STIR 0.15

Kill crop

Killing Frost

Knife, windrow dry beans – STIR 6.5

Land plane – STIR 10

Land plane; orchard and vine crops – STIR 6.2

Laser Land leveler – STIR 21

Lister, 30-inch – STIR 35

Lister, 30-inch with fertilizer applicator – STIR 37

Lister, 40-inch – STIR 35

Lister, 40-inch with fertilizer applicator – STIR 37

Log skidder – STIR 1.8

Manure injector, liquid high disturbance 30 inch – STIR 7.8

Manure injector, liquid low disturbance 15 inch – STIR 4.7

Manure injector, liquid low disturbance 30 inch – STIR 2.3

Manure injector, low disturbance 15 inch – STIR 4.7

Manure injector, low disturbance 30 inch – STIR 2.3

Manure spreader, liquid – STIR 0.29

Manure spreader, slurry – STIR 0.29

Manure spreader, solid and semi-solid – STIR 0.20

Manure, liquid irrigation – STIR 0.15

Middle buster, digger – STIR 52

Mow pasture – STIR 0.15

Mower, swather, on stubble – STIR 0.15

Mower, swather, on stubble 4 inch – STIR 0.15

Mower, swather, windrower – STIR 0.15

Mulch crimper – STIR 1.6

Mulch treader – STIR 10

No operation

Para-plow or para-till – STIR 18

Pasture renovator – STIR 5.2

Paving

Permeable weed barrier applicator – STIR 1.6

Planter, RELAY INTERCROP, double disk opener w/fluted coulter – STIR 2.4

Planter, double disk opener on 12-inch high beds – STIR 2.4

Planter, double disk opener on 15-inch high beds – STIR 2.4

Planter, double disk opener on 18-inch high beds – STIR 2.4

Planter, double disk opener on 8-inch high beds – STIR 2.4

Planter, double disk opener – STIR 2.4

Planter, double disk opener w/fluted coulter – STIR 2.4

Planter, double disk opener w/fluted coulter with starter fertilizer – STIR 3.3

Planter, double disk opener w/fluted coulter, 15-inch row spacing – STIR 4.9

Planter, double disk opener with starter fertilizer – STIR 3.3

Planter, double disk opener, 15-inch row spacing – STIR 4.9

Planter, double disk opener, 18-inch rows – STIR 4.1

Planter, double disk opener, 40-inch rows – STIR 1.6

Planter, furrow opener 4-inch deep furrows – STIR 7.8

Planter, furrow opener 6-inch deep furrows – STIR 23

Planter, furrow opener 8-inch deep furrows – STIR 42

Planter, in-row subsoiler – STIR 12

Planter, in-row subsoiler low disturbance – STIR 2.3

Planter, in-row subsoiler w/ residue managers – STIR 5.9

Planter, narrow slot w/smooth or rippled coulter – STIR 0.81

Planter, potato, 6-inch beds – STIR 29

Planter, ridge till – STIR 11

Planter, runner opener – STIR 2.6

Planter, small vegetable seed – STIR 0.59

Planter, small vegetable seed on 8-inch high beds – STIR 0.59

Planter, sprig conventional – STIR 13

Planter, sprig, no-till – STIR 0.52

Planter, sprigs on beds – STIR 26

Planter, strip till – STIR 4.9

Planter, strip till, 22 inch – STIR 8.1

Planter, strip till, shallow subsoiler – STIR 17

Planter, strip till, subsoiler – STIR 26

Planter, transplanter, vegetable – STIR 3.1

Planter, transplanter, vegetable on 8-inch high beds – STIR 3.1

Planter, transplanter, vegetable, no-till – STIR 3.1

Planter, twin row, double disk opener on 12-inch high beds – STIR 4.9
Planter, twin row, double disk opener – STIR 4.9
Planter, twin row, double disk opener with fluted coulter – STIR 4.9
Planter, tree, mechanical transplanter – STIR 4.7
Planting, broadcast interseeder - STIR 0.15
Planting, broadcast seeder – STIR 0.15
Planting, hand 10 percent disturbed – STIR 0.26
Planting, hand 5 percent disturbed – STIR 0.13
Planting, manual – STIR 0.78
Planting, manual on 8-inch high beds – STIR 0.78
Planting, no-till manually – STIR 0.78
Plastic hoop tunnel installation 100 percent cover – STIR 0.098
Plastic hoop tunnel installation 50 percent cover – STIR 0.049
Plastic hoop tunnel installation 75 percent cover – STIR 0.073
Plastic hoop tunnel installation on beds 50 percent cover – STIR 0.049
Plastic hoop tunnel installation on beds 75 percent cover – STIR 0.073
Plastic hoop tunnel removal on beds – STIR 0.098
Plastic hoop tunnel, removal – STIR 0.089
Plastic mulch application 40-inch beds 100 percent cover – STIR 1.6
Plastic mulch application 40-inch beds 75 percent cover – STIR 1.6
Plastic mulch application 48-inch beds 100 percent cover – STIR 1.3
Plastic mulch application 48-inch beds 80 percent cover – STIR 1.3
Plastic mulch application 54-inch beds 100 percent cover – STIR 1.2
Plastic mulch application 54-inch beds 80 percent cover – STIR 1.2
Plastic mulch application 64-inch beds 100 percent cover – STIR 1.0
Plastic mulch application 64-inch beds 85 percent cover – STIR 1.0
Plastic mulch applicator 100 percent cover – STIR 1.6
Plastic mulch applicator 40 percent cover – STIR 1.6
Plastic mulch applicator 50 percent cover – STIR 1.6
Plastic mulch applicator 75 percent cover – STIR 1.6
Plastic mulch, 5 percent removal – STIR 0.52
Plastic mulch, 10 percent removal – STIR 0.52
Plastic mulch, 25 percent removal – STIR 0.52
Plastic mulch, 50 percent removal – STIR 0.52
Plastic mulch, remove all – STIR 0.52
Plastic weed barrier 40-inch beds 100 percent cover – STIR 1.6
Plastic weed barrier 40-inch beds 50 percent cover – STIR 1.6
Plastic weed barrier 40-inch beds 75 percent cover – STIR 1.6
Plastic weed barrier applicator 100 percent cover – STIR 1.6
Plastic weed barrier applicator 50 percent cover – STIR 1.6
Plastic weed barrier applicator 75 percent cover – STIR 1.6
Plow, deep, large, moldboard – STIR 100
Plow, disk – STIR 39
Plow, moldboard – STIR 65
Plow, moldboard 10-inch depth – STIR 81
Plow, moldboard 6 to 7-inch depth – STIR 49
Plow, moldboard, conservation – STIR 42
Plow, moldboard, uphill – STIR 52
Plow, oxen 12-inch ridge – STIR 18
Plow, oxen 18-inch ridge – STIR 21
Plow, oxen on 6-inch ridge – STIR 16
Plow, oxen, strip 30 percent disturbance – STIR 4.7
Plow, oxen, strip 60 percent disturbance – STIR 9.4
Plow, reversible – STIR 52
Power mulcher bed conditioner – STIR 9.9
Pruning
Rake or windrower – STIR 1.0
Reel disk vertical tiller – STIR 45
Regrow
Remove Compost Sock – STIR 0.15
Remove Silt Fence – STIR 0.15
Remove Straw Bale – STIR 0.15
Residue conditioner, coil tine harrow, rolling basket – STIR 6.9
Residue removal by wind
Residue, row cleaner – STIR 1.1
Rice residue stomper – STIR 16
Ripper, intra row – STIR 13

Ripper, intra row and furrow diker – STIR 21
Road grader – STIR 5.2
Rodweeder – STIR 17
Rodweeder, harrow, spike tooth – STIR 20
Roller harrow – STIR 24
Roller, corrugated packer – STIR 1.5
Roller, corrugated packer 6 by 16 – STIR 2.9
Roller, crimp, cover crop – STIR 0.098
Roller, on beds – STIR 0.39
Roller, residue – STIR 0.098
Roller, residue incorporator – STIR 1.6
Roller, row shaper – STIR 0.98
Roller, smooth – STIR 0.98
Rolling basket incorporator – STIR 6.8
Root rake – STIR 36
Rotary hoe – STIR 17
Rotary hoe, on heavy soil – STIR 17
Rotary hoe, residue – STIR 2.1
Rototiller, field – STIR 18
Rototiller, field, add residue – STIR 18
Rototiller, on beds – STIR 8.2
Rototiller, row cultivation add residue – STIR 12
Rototiller, row cultivator – STIR 8.7
Scalper, tree – STIR 2.6
Scarifier – STIR 31
Scraper/pan/grader, clearing/cutting – STIR 13
Seedbed conditioner, coil tine harrow, rolling basket – STIR 15
Seedbed conditioner, coulter caddy, coil tine harrow – STIR 17
Seedbed conditioner, coulter caddy, coil tine harrow, rolling basket – STIR 21
Seedbed conditioner, coulter caddy, field cult, spike harrow – STIR 22
Seedbed conditioner, coulter caddy, rotary harrow – STIR 16
Seedbed conditioner, coulter caddy, rotary harrow, rolling basket – STIR 20
Seedbed conditioner, coulter caddy, spike harrow – STIR 17
Seedbed conditioner, coulter caddy, spike harrow, rolling basket – STIR 19
Seedbed finisher – STIR 22
Seedbed finisher, field cult, rolling chopper, spike harrow, rolling basket – STIR 39
Seedbed finisher, field cult, coil tine harrow, rolling basket – STIR 36
Seedbed finisher, field cultivator, mulch treader – STIR 22
Seedbed finisher, field cultivator, rotary harrow – STIR 22
Seedbed finisher, single disk, field cultivator, coil tine harrow, rolling basket – STIR 37
Seedbed finisher, single disk, rotary harrow – STIR 17
Seedbed finisher, single disk, field cultivator, coil tine harrow – STIR 36
Seeder, corrugated packer – STIR 0.98
Seeder, dormant, corrugated packer – STIR 0.98
Seeder, high density vegetable – STIR 0.73
Seeder, broadcast
Shred residue, 6-inch stubble – STIR 0.15
Shred standing residue in live cover crop – STIR 0.15
Shredder, flail or rotary – STIR 0.15
Shredder, flail or rotary, add other cover – STIR 0.15
Shredder, flail or rotary, filberts and pecans – STIR 0.15
Shredder, rotary mower – STIR 0.15
Shredder, rotary, regrow vegetation – STIR 0.15
Shredder, rotary, remove residue – STIR 0.15
Slip plow 48 to 60 inches deep – STIR 21
Sod cutter – STIR 0.24
Sod installation
Spader – STIR 18
Spader, shallow depth – STIR 11
Spray, glyphosate on resistant growing crop – STIR 015
Sprayer, backpack, kill vegetation – STIR 0.15
Sprayer, backpack, post emergence – STIR 0.15
Sprayer, defoliant – STIR 0.15
Sprayer, fungicide – STIR 0.15
Sprayer, fungicide and insecticide tank mix – STIR 0.15
Sprayer, growth regulator – STIR 0.15
Sprayer, insecticide post emergence – STIR 0.15
Sprayer, kill cover in growing crop – STIR 0.15
Sprayer, kill cover in growing vegetables – STIR 0.15
Sprayer, kill crop – STIR 0.15
Sprayer, kill strips – STIR 0.15

Sprayer, post emergence – STIR 0.15

Sprayer, post emergence and fertilizer tank mix – STIR 0.15

Sprayer, pre-emergence – STIR 0.15

Stalk chopper, rolling – STIR 31

Stalk chopper, rolling, light disturbance – STIR 7.0

Stalk chopper, rolling, on ridgetill ridges – STIR 20

Stalk chopper, rolling, strip – STIR 25

Stalk chopper, rotary – STIR 31

Stalk chopper, strip rotary – STIR 25

Stalk puller – STIR 19

Stalk puller high disturbance – STIR 30

Stalk slicer – STIR 6.6

Stop Grazing

Strip till bed conditioner – STIR 4.9

Striptiller w/ middlebuster on beds – STIR 7.0

Subsoil disk ripper – STIR 58

Subsoil disk ripper, coulter smooth, rolling basket – STIR 67

Subsoil disk ripper, roller smooth – STIR 59

Subsoiler – STIR 33

Subsoiler bedder (ripper/hipper) – STIR 46

Subsoiler leveler – STIR 38

Subsoiler ripper, 24 to 40 inches deep – STIR 21

Subsoiler, 12 foot spacing – STIR 6.6

Subsoiler, in row – STIR 12

Subsoiler, in row strip conditioner – STIR 14

Subsoiler, in row strip conditioner, 40-inch row – STIR 11

Subsoiler, inline heavy shanks with coulter caddy – STIR 39

Subsoiler, inline with coulter caddy – STIR 35

Subsoiler, rolling stalk chopper, roller, mulch treader – STIR 60

Subsoiler, wide spacing – STIR 8.8

Subsoiler; stalk chopper, rolling – STIR 35

Sweep plow 20-40 inch wide – STIR 9.8

Sweep plow wider than 40-inch w/ mulch treader – STIR 2.9

Sweep plow, under beds – STIR 15

Sweep plow, wider than 40 inches – STIR 7.8

Sweep, single under row – STIR 4.7

Sweep, single under row, regrow perennial – STIR 3.9

Tree spade, holes left – STIR 19

Tree spade, holes plugged – STIR 4.7

Water mulch; off

Water mulch; on

Weed control, hoeing in row – STIR 0.59

Weed control, manual hoe – STIR 3.3

Weed control, string trimmer – STIR 0.15

Weeder, finger weeder – STIR 0.49

Winter kill annual crop